Abundance and Run Timing of Dolly Varden in the Middle Fork Goodnews River, 2007

Alaska Fisheries Data Series Report Number 2008-7

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Mark J. Lisac

Abstract

Dolly Varden annual run timing, total run and spawner abundance were estimated in the Middle Fork Goodnews River using a salmon escapement monitoring weir from 25 June to 10 September, 2007. The 2007 run timing is consistent with historical run monitoring, but total abundance of 1,692 was the lowest on record and only 61% of the 1996 to 2006 average run of 2,786. The number of mature, prespawning Dolly Varden was estimated by apportioning the weir counts based on a sample of 324 fish caught in the weir live trap. In 2007, approximately 1,120 mature Dolly Varden passed upstream of the weir. Previous estimates for the years 2001 through 2004 averaged approximately 1,318 (range 735 to 2,292) mature Dolly Varden.

Introduction

Dolly Varden are an important component of the subsistence harvest, the sport fishery and the ecosystem in the Goodnews River drainage in southwest Alaska. Although no quantitative harvest estimate is available for the Goodnews River Dolly Varden subsistence fishery, Dolly Varden are likely harvested in such quantities to match or exceed the harvest of salmon by weight (Wolfe et al.1984). Between 2001 and 2005, the sport catch has averaged 15,189 char (Dolly Varden and Arctic char combined) in the entire Goodnews River (Chythlook 2006). This catch ranks second behind the Kanektok River among all estimated sport fisheries in the Kuskokwim region.

To aid in developing a long term monitoring program for Dolly Varden populations in southwest Alaska, the Togiak National Wildlife Refuge (Refuge) initiated research to learn more about their life history and habitat use throughout the Refuge (Lisac and Moran 1999; Lisac and Nelle 2000; Reynolds 2000; Lisac and Buchholtz 2001; Crane et al. 2003; Lisac 2006, 2007b; Lisac and Bromaghin 2007) and specifically in the Middle Fork Goodnews River (MFGR) (Lisac 2004, 2007a). Radio telemetry and visual marking have been used to document biological characteristics, life history aspects, and to identify spawning and overwintering areas of anadromous Dolly Varden in the MFGR drainage (Lisac 2004). Dolly Varden annual run timing, total run and spawner abundance have been estimated in the MFGR using a salmon escapement monitoring weir since 1996 (Lisac 2004, 2007a). For some years, the run has been bi-modal, but for most years the majority of the run occurs between 10 and 25 July. For all years from 1996 to 2006, the run has averaged 2,786 fish and ranged between 1,761 and 6,616 fish (Appendix 1).

Using the annual returns of Dolly Varden as the basis for monitoring population health and abundance is difficult because stocks of mixed origin and maturity usually enter the rivers together (DeCicco 1985; Whalen 1992; Larson 1997; Lisac and Nelle 2000; Lisac 2004, 2006, 2007a, 2007b). Estimating the number of Dolly Varden spawners returning annually to the drainage would be more useful for understanding long-term population trends. This

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has been accomplished by apportioning the daily counts by a maturity index. Beginning in 2001, the annual passage of mature, prespawning Dolly Varden into the MFGR was estimated by apportioning the weir counts based on the maturity of fish sampled from the weir live trap (Lisac 2004, 2007a). From 2001 to 2006, approximately 13% to 35% of the annual Dolly Varden run counted at the weir during July to mid-August was captured. For three of those years, the sample sizes were adequate to determine the proportion of mature fish. Prespawners accounted for 40.3%, 49.3% and 68.5% of the sample from 2001, 2003 and 2004, respectively. During these years, an estimated 703, 927, and 2,292 prespawning Dolly Varden passed upstream of the weir.

The purpose of this report is to provide a summary of the data collected during the 2007 season and compare it to past results. The objectives addressed in this report are to: 1) determine the annual run timing of Dolly Varden passing upstream of the MFGR weir; 2) estimate the number of prespawning Dolly Varden passing the MFGR weir during July to mid-August; and, 3) collect length, sex and maturity data from Dolly Varden immigrating past the MFGR weir.

Study Area

The Goodnews River drainage occurs within the 19,021 km^2 Togiak National Wildlife Refuge in southwest Alaska. The drainage consists of three river channels which drain approximately 2,600 km^2 in the Ahklun Mountains (USFWS 1990; Figure 1). The MFGR is approximately 68 km long. It parallels the North Fork Goodnews River (75 km) branch, which diverges from the MFGR approximately 6.5 km upstream of Goodnews Bay. Two branches flow from the Middle Fork Lakes for approximately 10 km and join to form the main MFGR. Kukaktlik River is the only named tributary to the MFGR and flows southwest from Kukaktlim Lake for approximately 33 km to join the MFGR approximately 55 km upstream of the confluence with the North Fork Goodnews River. The weir is located approximately 18 km upstream of Goodnews Bay on the MFGR.

Methods

Dolly Varden migrating upstream in the MFGR are counted at the weir and recorded as daily totals. Estensen (2001) provided a detailed description of how this weir is configured and operated, and Lisac (2004, 2007a) provided details of how the weir was used to capture Dolly Varden in the years prior to 2007. In 2007, an additional live trap was added to the weir as part of an underwater video monitoring system (Lawonn and Lisac in prep). The design of this new trap allowed the trap to fish effectively over night. The trap was inspected using snorkel gear each morning and any Dolly Varden seen were netted from the trap. Dolly Varden were also captured intermittently throughout the sample time stratum by baiting the live trap with salmon roe. All fish that could be captured were sampled with a minimum sample size goal of 10% of the total Dolly Varden counted during each time stratum. Capture and sampling efforts concentrated on the early portion of the run between early July and mid-August when the proportion of prespawning Dolly Varden is higher (Larson 1997; Lisac and Nelle 2000; Lisac 2004, 2006, 2007a).

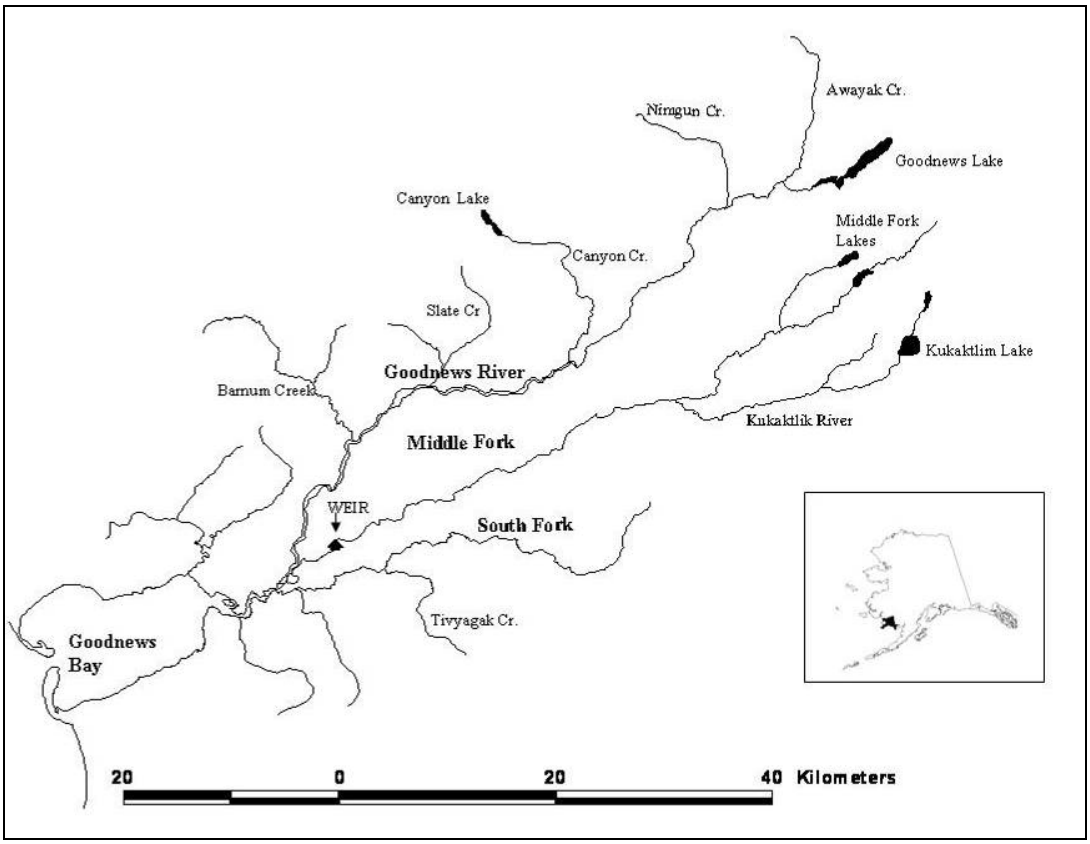

FIGURE 1. —Goodnews River drainage.

Dolly Varden were measured for fork length to the nearest 1.0 mm. Length frequency distributions in 10 mm increments were calculated for all Dolly Varden from each annual sample. Dolly Varden greater than 250 mm were marked with an individually numbered T-bar anchor tag. Sex, color code and maturity were recorded for each fish. Fin clips were collected from all captured fish, stored in alcohol vials segregated on sex and maturity, and archived for future genetic analysis.

Maturity of fish was determined using external characteristics with periodic comparison to internal examination of gonad development by dissection as previously reported by Lisac (2006) and adapted from DeCicco (1985). Maturity classifications were: immature, nonspawner, prespawner, or unknown. Photographic keys were used to train field personnel to identify sex and maturity of fish based on external characteristics. The primary external characteristics used were the coloration of the body, head, jaw and fins. Fish were characterized as being either 1) silver or showing no color; 2) showing signs of color change (darkening opercle, head and jaws, reddening of fins with white leading edge); or 3) full spawning colors. Head shape, kype formation, a swollen ovipositor or abdomen were used as sex determinant characteristics.

The sample period was divided into 3 time strata: prior to 21 July, 21 to 31 July, and after 31 July. The proportion of prespawners in each time stratum was estimated as a proportion (Cochran 1977; Larson 1997) of the combined daily samples in each time stratum. The number of prespawning

fish was estimated by multiplying the total Dolly Varden weir count for each time stratum by the proportion of prespawners in the sample for that time stratum (Larson 1997; Lisac 2006). The total number of Dolly Varden prespawners passing through the weir was estimated by summing the estimate and variance of each time stratum. Fish counted by Department staff prior to our arrival were apportioned by extrapolation using the proportion of prespawners observed in the sample during the first time stratum.

Results

The MFGR weir operated for a total of 78 days from 25 June to 10 September 2007 (Appendix 1; Appendix 5). A total of 1,692 Dolly Varden were counted through the weir. The first Dolly Varden was counted on 26 June and the midpoint of the run occurred on 18 July, approximately 7 days earlier than the long term average date (Figures 2; Figure 3; Appendix 1). Approximately 50% of the run arrived during the19-day period between 10 and 28 July.

A total of 324 Dolly Varden were captured during 37 days of sampling between 5 July and 10 September (Table 1; Figure 3). Of these 318 fish were measured for fork length (Figure 4; Appendix 3; Appendix 4). Fork length ranged 239 mm to 656 mm and averaged 450.1 mm (SD = 73.31). Fork length recorded for prespawners (n = 208) ranged from 339 mm to 656 mm and averaged 483.5 mm (SD = 62.40). Fork length recorded for fish with unknown maturity (n = 106) ranged from 239 mm to 498 mm and averaged 386.5 mm (SD = 44.87).

Thirty fish were sacrificed (12) or found dead on the weir. Complete information was recorded for 24 of these fish. Preliminary sex and maturity determinations were 91.7% correct compared to the actual sex and maturity determined by dissection. These fish ranged in fork length from 318 mm to 630 mm, and averaged 483.5 mm (SD = 13.37).

All 324 fish captured were used for apportioning the 1,692 Dolly Varden counted during the sample period (Table 1; Figure 5). The sample was comprised of 211 (65.1%) prespawning fish, 112 unknown maturities and 1 nonspawner. An estimated 1,120 (SE = 28.1) prespawning Dolly Varden passed upstream of the weir between 25 June and 10 September.

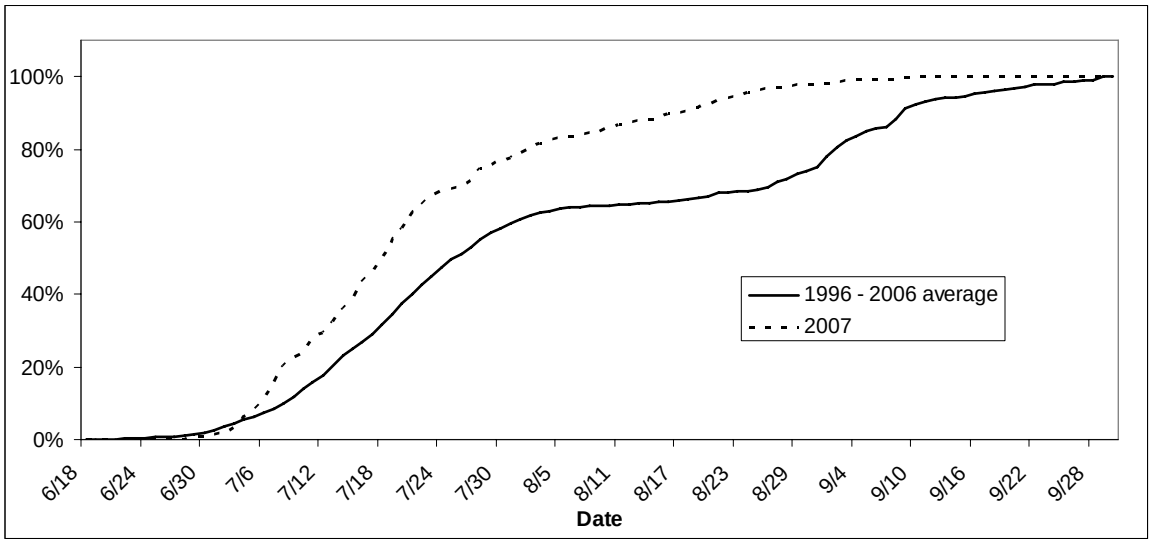

FIGURE 2. —Recent and historical average cumulative counts expressed as a proportion of the total run of Dolly Varden, by day, at the MFGRW.

TABLE 1. —Estimated number of prespawning (PR) Dolly Varden from the MFGR by time strata in 2007.

Time strata	Weir count	Number sampled	Percent sampled	Number PR	Percent PR in sample	Estimated PR	SE
1	984	146	14.8%	116	79.5%	782	24.2
2	327	146	44.6%	82	56.2%	184	5.6
3	381	32	8.4%	13	40.6%	155	13.1
Total	1,692	324	20.4%	211	65.1%	1,120	28.1

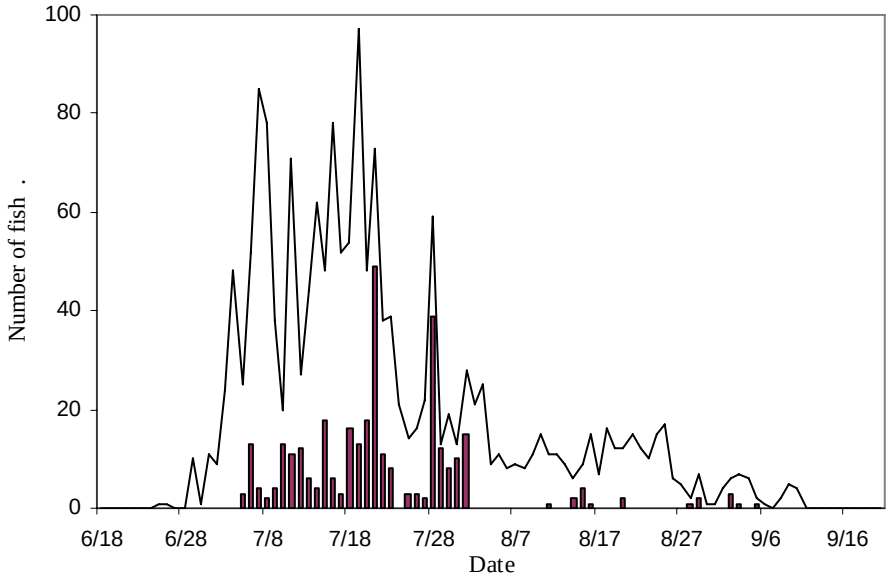

FIGURE 3. —Number of Dolly Varden counted (line) and captured (bar) at the MFGR weir, 2007.

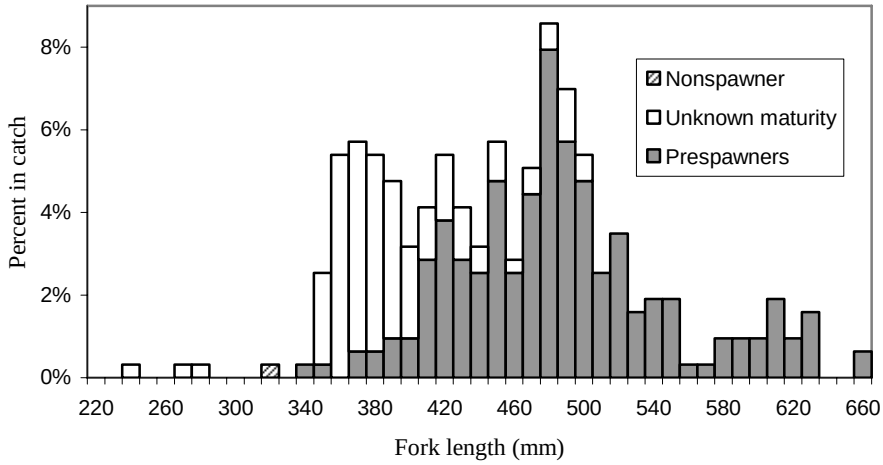

FIGURE 4. —Fork length frequency distribution for Dolly Varden caught in the MFGR, 2007 by maturity.

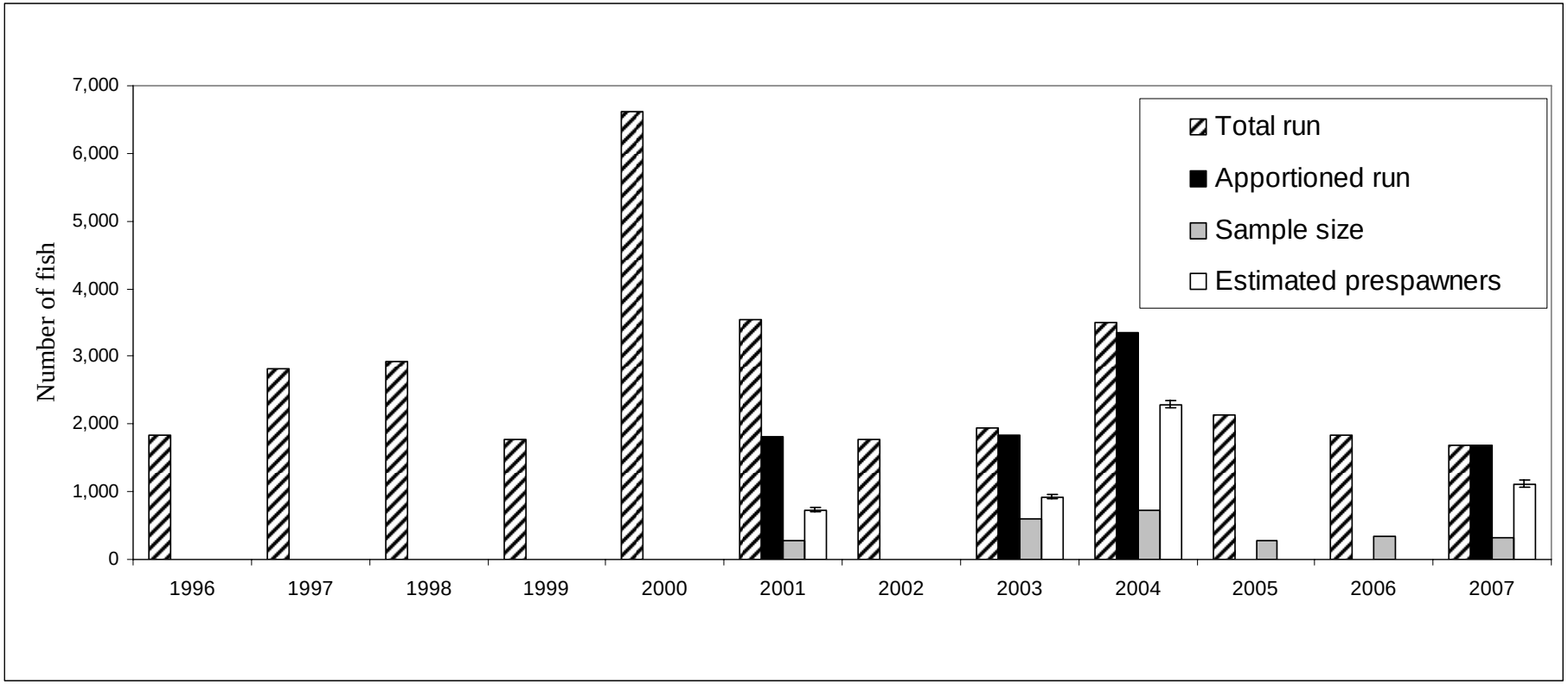

FIGURE 5. —Historical number of Dolly Varden counted for the season (total run), counted during study period (apportioned run), the number sampled, and estimated prespawner abundance with 95% confidence intervals for years when available, MFGR weir, 1996 - 2007.

Discussion

The objectives to document run timing and biological characteristics of Dolly Varden in the Middle Fork Goodnews River were successfully achieved in 2007. The 2007 run timing is consistent with historical run monitoring, but the total Dolly Varden run (N = 1,692) was the lowest on record (Appendix 1; Appendix 2). The 2007 run was only 61% of the 1996 through 2006 average of 2,786 and only 25.6% of the largest run recorded in 2000 (N = 6,616). As in most other years, over 70% of the run passed the weir prior to 1 August 2007.

The estimated 1,120 mature, prespawning Dolly Varden that passed upstream of the weir in 2007 was similar to estimates for the years 2002 through 2004, which averaged approximately 1,318 (ranged 735 to 2,292) (Appendix 5; Appendix 6). The proportion of prespawners (79.5%) in the early part of the run, prior to 21 July, was the second highest observed since 2001. The overall proportion of prespawners in the sample collected in 2007 (65.1%) was within the range (approximately 40% to 69%) observed in past years when estimates were made.

The objective of estimating the abundance of prespawning Dolly Varden in the MFGR has proven to be more difficult to accomplish and this estimate should be considered conservative. Representing the composition of the run is difficult due to the location and design of the weir, and the consistency of determining sexual maturity using non-lethal observations of external characteristics. Determining maturity based on external factors is more reliable after the fish have resided in freshwater for a greater period of time and are closer to spawning time and locations. Because the weir is within 18 river kilometers from Goodnews Bay, Dolly Varden migrating upstream may not have spent sufficient time in freshwater to develop the external characteristic of prespawning char. Even when comparing the external morphology of sacrificed fish with gonad development, determining the maturity of Dolly Varden less than 420 mm in length was difficult because external characteristics are less developed. The smallest mature (prespawning) fish measured was 339 mm. There were 118 (36%) of the 324 fish measured between 339 mm and 420 mm. Using this same proportion provides an estimate of 616 fish of the 1,692 fish in the total weir count that were in the smaller size range, and potentially assigned an incorrect maturity status. Approximately 35% of these smaller fish were determined to be prespawners, compared to an overall 85% for those fish greater than 420 mm. It is likely that the actual proportion of prespawners in the fish less than 420 mm lies somewhere in between these two values. Future monitoring of the Dolly Varden run in the MFGR should continue to improve on maturity determination, especially in those fish less than 420 mm, and include a more detailed apportioning of the run by maturity and size strata. Annual collection and archiving of genetic tissue should continue. The completion of a genetic stock identification baseline for Dolly Varden throughout western Alaska, currently being pursued in another study, will hopefully one day allow a reliable method to apportion this Dolly Varden run into stocks based on river of origin.

Acknowledgements

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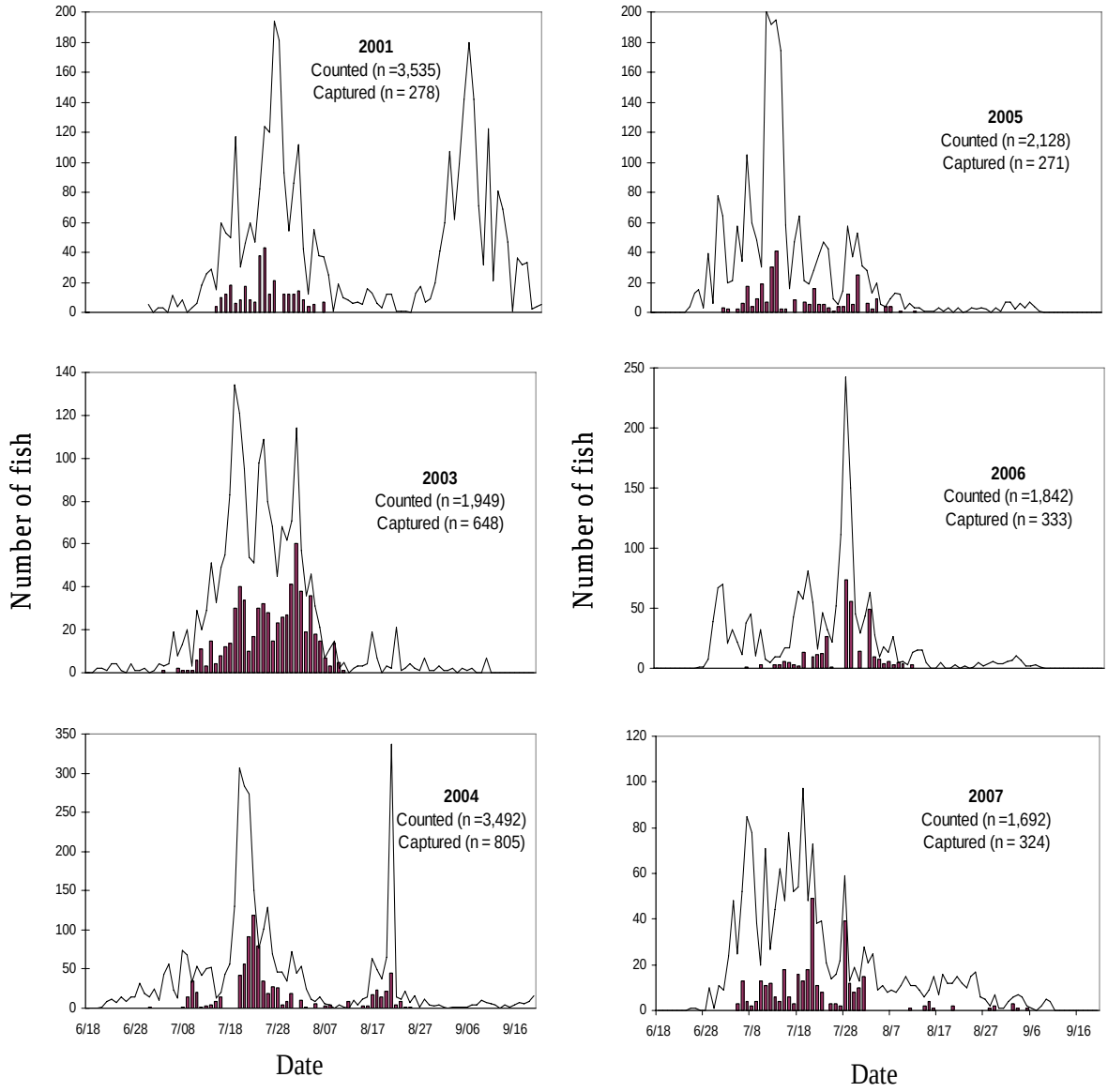
APPENDIX 1. —Historical daily Dolly Varden passage at Middle Fork Goodnews River weir showing the midpoint (box), and peak (50%) of the run (shaded area), 1996 - 2007. (page 1 of 2)

Date	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
6/18								0				
6/19								0				
6/20								2				
6/21								2	1			
6/22								1	9			
6/23	0	0						4	11			
6/24	5	4						4	7			
6/25	1	0					4	1	14			1
6/26	10	0				0	0	0	9	4		1
6/27		2				0	1	4	14	13	1	0
6/28		16				0	2	1	14	15	1	0
6/29		2				0	1	1	32	3	8	10
6/30		9				0	1	2	19	39	39	1
7/01	65	30				5	2	0	14	6	67	11
7/02	40	120			3	0	7	1	25	78	70	9
7/03	51	118			0	3	7	4	10	64	21	24
7/04	63	117	1	2	6	3	7	3	44	20	32	48
7/05	84	110	3	3	6	0	0	4	56	21	22	25
7/06	108	217	7	1	7	11	8	19	23	57	11	52
7/07	88	172	7	0	3	4	25	8	13	34	38	85
7/08	39	189	13	0	27	8	26	13	74	105	45	78
7/09	83	207	42	1	36	0	63	20	68	60	10	38
7/10	193	332	45	2	59	3	100	3	33	48	32	20
7/11	28	230	37	5	34	6	239	29	54	30	8	71
7/12	65	104	97	6	35	18	112	20	42	201	5	27
7/13		71	113	7	44	26	278	29	51	192	9	44
7/14		138	167	12	16	29	261	51	52	195	9	62
7/15		74	148	22	98	15	74	33	13	174	17	48
7/16		103	105	60	47	60	125	49	20	58	17	78
7/17		43	192	25	49	53	132	55	43	16	42	52
7/18		101	283	33	47	50	102	83	56	47	64	54
7/19		78	231	20	143	117	24	134	130	64	58	97
7/20	17	64	170	60	145	30	25	121	307	21	81	48
7/21	87	16	300	48	72	46	22	95	283	19	55	73
7/22	73	26	204	90	75	60	28	54	274	28	16	38
7/23	60	15	172	138	22	47	12	51	150	38	46	39
7/24	160	11	89	267	53	82	8	98	76	47	32	21
7/25	163	9	126	92	25	124	3	109	101	42	22	14
7/26	72	6	29	50	10	120	4	80	128	9	52	16
7/27	75	4	25	108	5	194	0	68	69	5	111	22
7/28	60		8	108	22	181	2	45	47	14	242	59
7/29			4	168	11	93	5	68	47	57	150	13
7/30			23	31	12	54	1	62	34	37	45	19
7/31		2	29	122	7	86	9	71	73	53	29	13
8/01		7	17	43	6	112	0	114	45	31	43	28
8/02		5	23	104	1	42	5	57	53	28	63	21
8/03		1	21	54	0	12	9	36	24	13	27	25
8/04		1	11		0	55	2	46	12	20	9	9
8/05		2	12		0	38	2	31	8	5	18	11
8/06		8	11		0	37	0	21	15	4	13	8
8/07		2	7		0	25	0	7	6	9	26	9

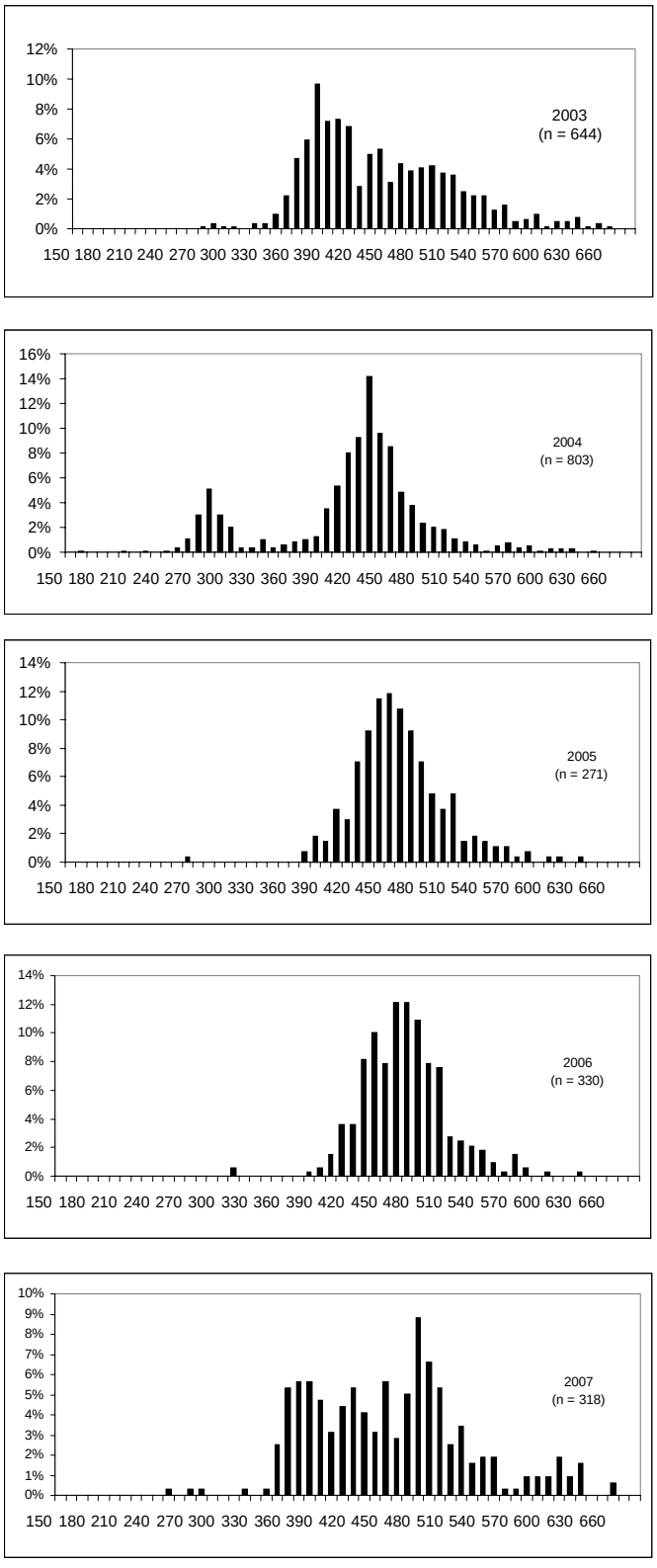
APPENDIX 1. —Historical daily Dolly Varden passage at Middle Fork Goodnews River weir showing the midpoint (box), and peak (50%) of the run (shaded area), 1996 - 2007. (continued; page 2 of 2)

Date	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
8/08	3	0	3		0	1	0	11	4	13	5	8
8/09	0	0	9		0	19	2	15	0	12	6	11
8/10	4	0	16		3	10	1	2	5	2	3	15
8/11	15		18		2	8	0	5	1	6	13	11
8/12	10		3		1	6	1	0	0	3	15	11
8/13	18	16	1		3	7	0	2	10	3	15	9
8/14	7	4	2	0	3	5	1	3	5	1	5	6
8/15	6	1	1	5	3	16	1	3	12	1	0	9
8/16	8	8	12	2	7	13	0	4	14	1	0	15
8/17	11	3	5	4	13	6	0	19	63	3	5	7
8/18	11	0	4	11	10	3	3	7	49	1	0	16
8/19	12	1	1	6	35	12	0	0	37	3	0	12
8/20	8	1		4	38	12	0	3	65	0	3	12
8/21	14	0	8	4	36	1	0	2	337	3	0	15
8/22	9	0	3	6	13	1	0	21	15	0	2	12
8/23	3	0	3	5	28	1	1	1	12	1	0	10
8/24		6	8	4	36	0	0	2	21	3	1	15
8/25		0	9	1	48	13	1	4	7	2	5	17
8/26		2	1	4	188	17	1	2	16	3	2	6
8/27		0	10	6	452	7	0	1	1	2	4	5
8/28		0	5	3	225	9	0	7	12	0	6	2
8/29			1	3	378	20	0	1	5	3	4	7
8/30			4	7	154	41	0	1	3	1	4	1
8/31			1	4	219	60	0	3	4	7	6	1
9/01		0	1		751	107	0	1	2	7	7	4
9/02			1		676	62	1	1	0	2	10	6
9/03			7		385	99	0	2	1	6	7	7
9/04			0		89	142	1	0	1	3	2	6
9/05			3		198	180	1	2	1	7	2	2
9/06			1		66	142	5	1	2	4	3	1
9/07			2		13	71	3	2	5	1	1	0
9/08					414	32	6	0	4	0		2
9/09					404	122	0	0	10	0		5
9/10					184	21	1	7	7	0		4
9/11					57	81	0	0	6	0		
9/12					64	69	2	0	5	0		
9/13					24	47	0	0	0			
9/14					7	1	0	0	4			
9/15					47	36	0	0	1			
9/16					62	32	0	0	4			
9/17					57	33	0	0	7			
9/18					3	2	0	0	6			
9/19					31	4			9			
9/20					34	5			16			
9/21					13	6						
9/22					16	36						
9/23						0						
9/24						3						
9/25						16						
9/26						4						
9/27						10						
9/28						3						
9/29						30						
9/30						2						
Total	1,829	2,808	2,915	1,761	6,616	3,535	1,770	1,949	3,492	2,128	1,842	1,692

APPENDIX 2. —Number of Dolly Varden counted (line) and captured (bar) at the Middle Fork Goodnews River weir by date, 2001 to 2007.



APPENDIX 3. —Fork length frequency distribution expressed as percent of sample and the number of Dolly Varden sampled per year at the Middle Fork Goodnews River weir, 2003 to 2007.



APPENDIX 4. —Mean fork length and size range for Dolly Varden caught at the Middle Fork Goodnews River weir, 2003 - 2007.

	2001	2003	2004	2005	2006	2007
All						
Mean FL	477.0	436.0	409.4	456.5	464.7	450.1
SD	55.28	67.79	71.90	44.38	40.08	73.31
Minimum	308	268	159	255	310	239
Maximum	619	660	643	625	625	656
N	278	644	803	271	330	318
Prespawners						
Mean FL	523.0	455.7	441.8	484.6	492.5	483.5
S.D.	40.77	70.35	47.41	43.63	40.18	62.40
Minimum	431	271	324	418	419	339
Maximum	619	641	643	607	565	656
N	112	294	489	18	22	208

APPENDIX 5. —Dates of operation, total run, sample size and estimated prespawning Dolly Varden at the MFGR weir, 2001 to 2007.

	2001	2003	2004	2005	2006	2007
Dates of weir operation	7/1 – 9/30	6/18 – 9/18	6/21 – 9/20	6/26 – 9/12	6/26 – 9/07	6/25-9/10
Total run	3,535	1,949	3,492	2,128	1,842	1,692
Sample period dates	7/6 – 8/6	7/3 – 8/28	6/17 – 8/26	6/26 – 8/14	6/28 – 8/28	7/5-9/10
Number of fish captured	278	648	805	271	333	324
Number of fish used for apportioning weir counts[1]	278	594	715	18	22	324
Percent prespawners	40.3%	49.3%	68.4%	6.6%	6.6%	65.1%
Apportioned dates	7/15 – 8/6	6/20 – 8/10	6/21 – 8/24	NA	NA	7/5 – 9/10
Apportioned weir count	1,824	1,842	3,353			1,692
Estimated prespawners	735	927	2,292			1,120
SE[2]	20.6	18.4	29.2			28.1

[1] Only days with complete capture information and maturity index assignments were used.
[2] SE corrected from Lisac 2007a

APPENDIX 6. —Estimated prespawning (PR) Dolly Varden at the MFGR weir by time strata, 2001 to 2007.

Year	Time strata	Weir count	Number sampled	Percent sampled	Number PR	Percent PR in sample	Estimated PR	SE[1]
2001	1	441	58	13.2%	17	29.3%	129	7.3
	2	1,087	182	16.7%	74	40.7%	442	14.7
	3	296	38	12.8%	21	55.3%	164	12.5
	Total	1,824	278	15.2%	112	40.3%	735	20.6
2003	1	701	106	15.1%	48	45.3%	317	14.2
	2	801	283	35.3%	173	61.1%	490	11.4
	3	340	205	60.3%	72	35.1%	119	2.5
	Total	1,842	594	32.2%	293	49.3%	927	18.4
2004	1	1,258	144	11.4%	135	93.8%	1,179	22.5
	2	1,282	485	37.8%	328	67.6%	867	14.5
	3	813	86	10.6%	26	30.2%	246	11.6
	Total	3,353	715	21.3%	489	68.4%	2,292	29.2
2007	1	984	146	14.8%	116	79.5%	782	24.2
	2	327	146	44.6%	82	56.2%	184	5.6
	3	381	32	8.4%	13	40.6%	155	13.1
	Total	1,692	324	20.4%	211	65.1%	1,120	28.1

[1] SE corrected from Lisac 2007a.